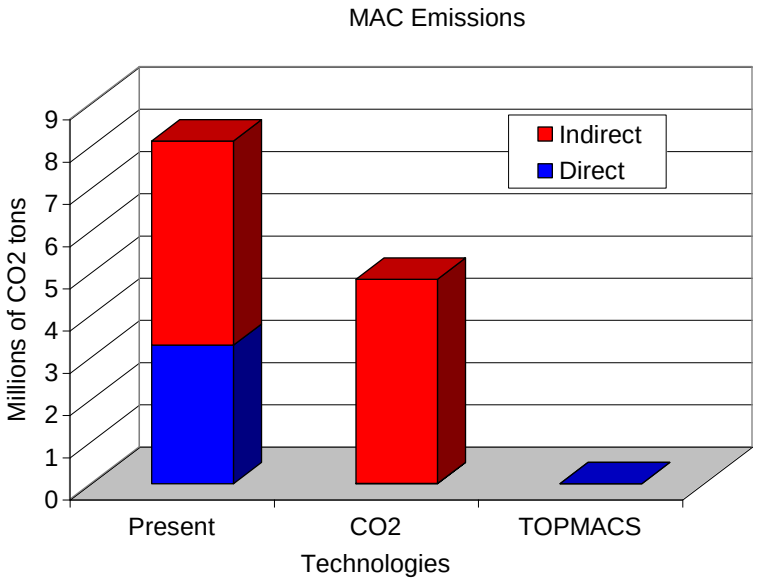
Waste heat to power car air conditioning (TOPMACS)

Dr Z. Tamainot-Telto, CEng, MIMechE, MInstR
School of Engineering - University of Warwick
Coventry CV4 7AL - UK

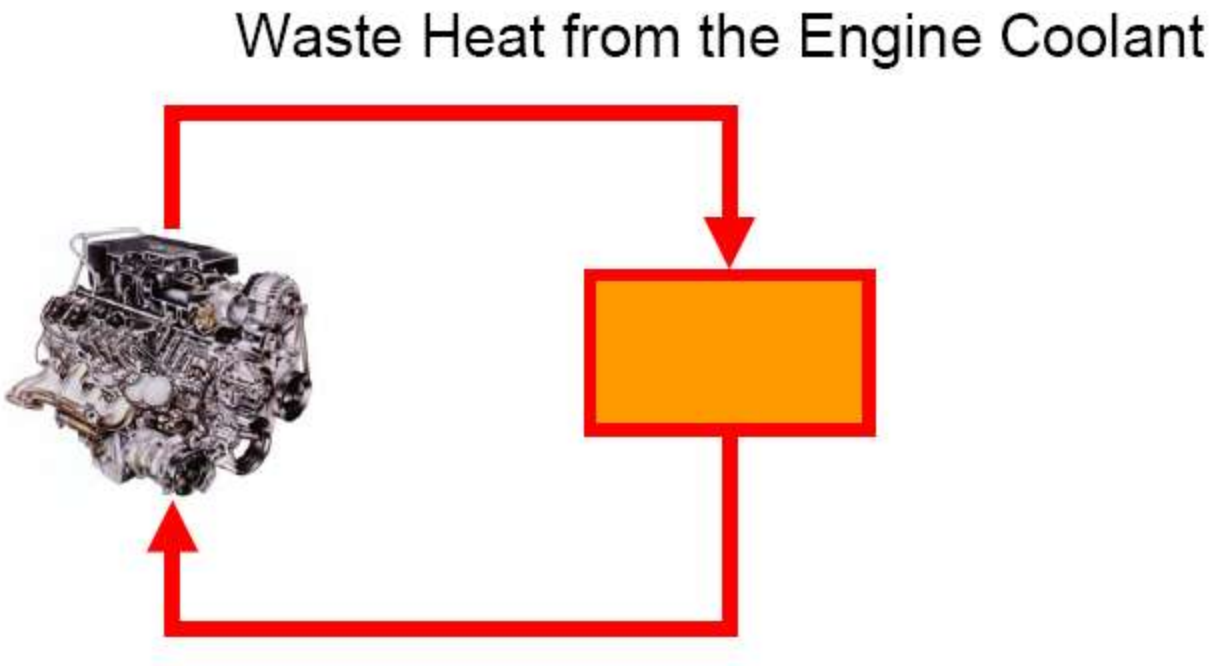
THE UNIVERSITY OF WARWICK

Introduction: Car AirCon - TOPMACS

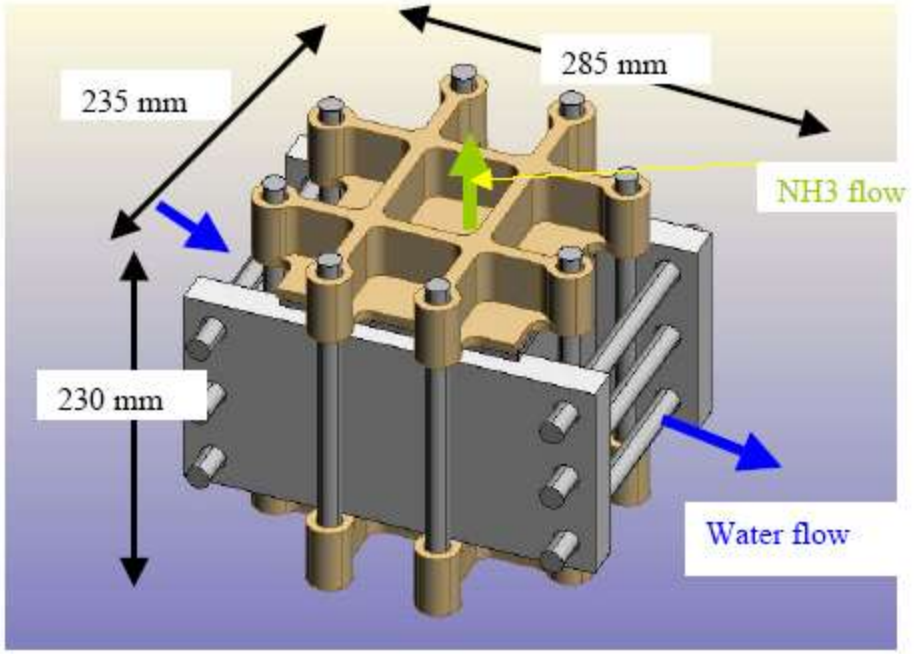
- Environment: Green house gases (HFC) and CO2 emissions. Energy savings.
- Vehicle HFC contribution in EU: 210M cars
- 750 to 2500 tons/y of R134a is leaked : 30%
- CO2 emission due to conventional MAC : 8%
- Development of MAC –


MAC Emissions
Millions of CO2 tons
0
1
2
3
4
5
6
7
8
9
Indirect
Direct
Present
CO2
TOPMACS
Technologies

Car AirCon

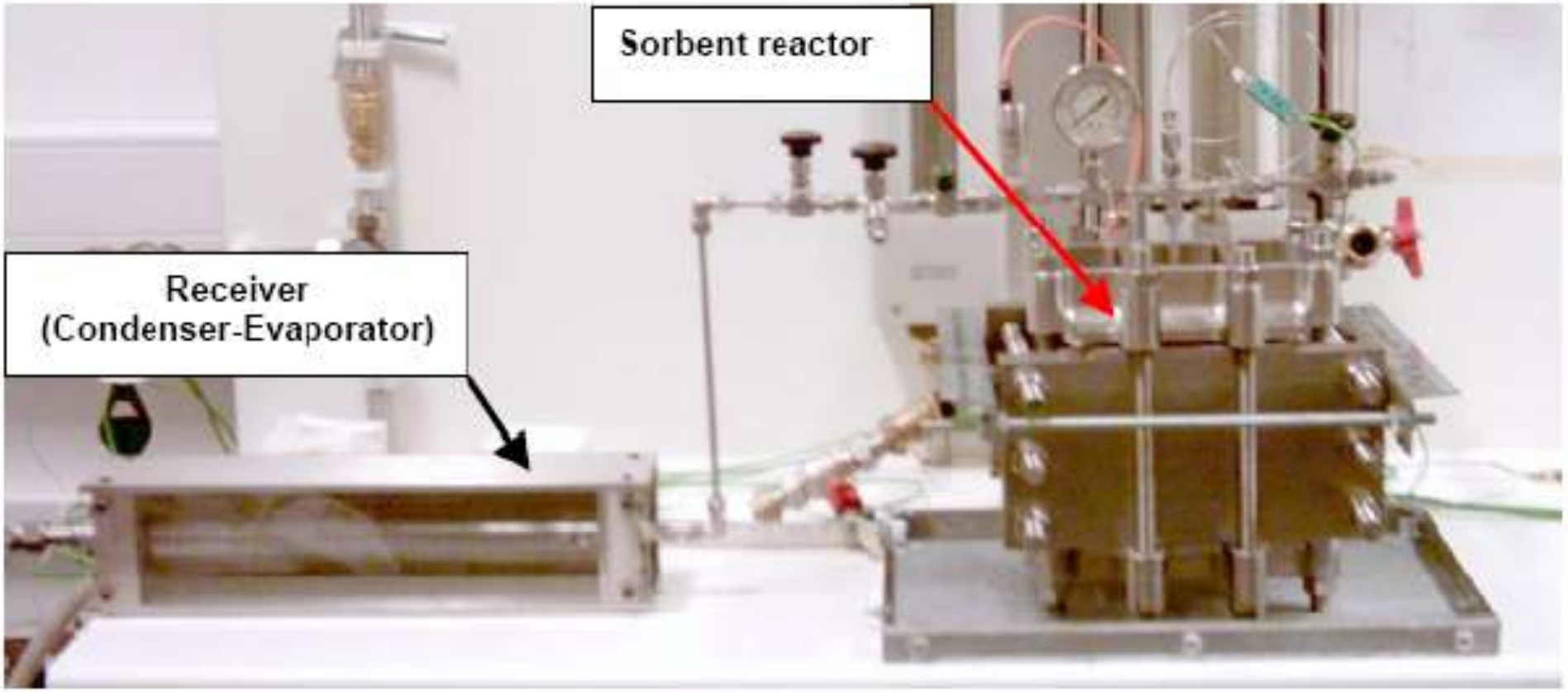

Waste Heat from the Engine Coolant

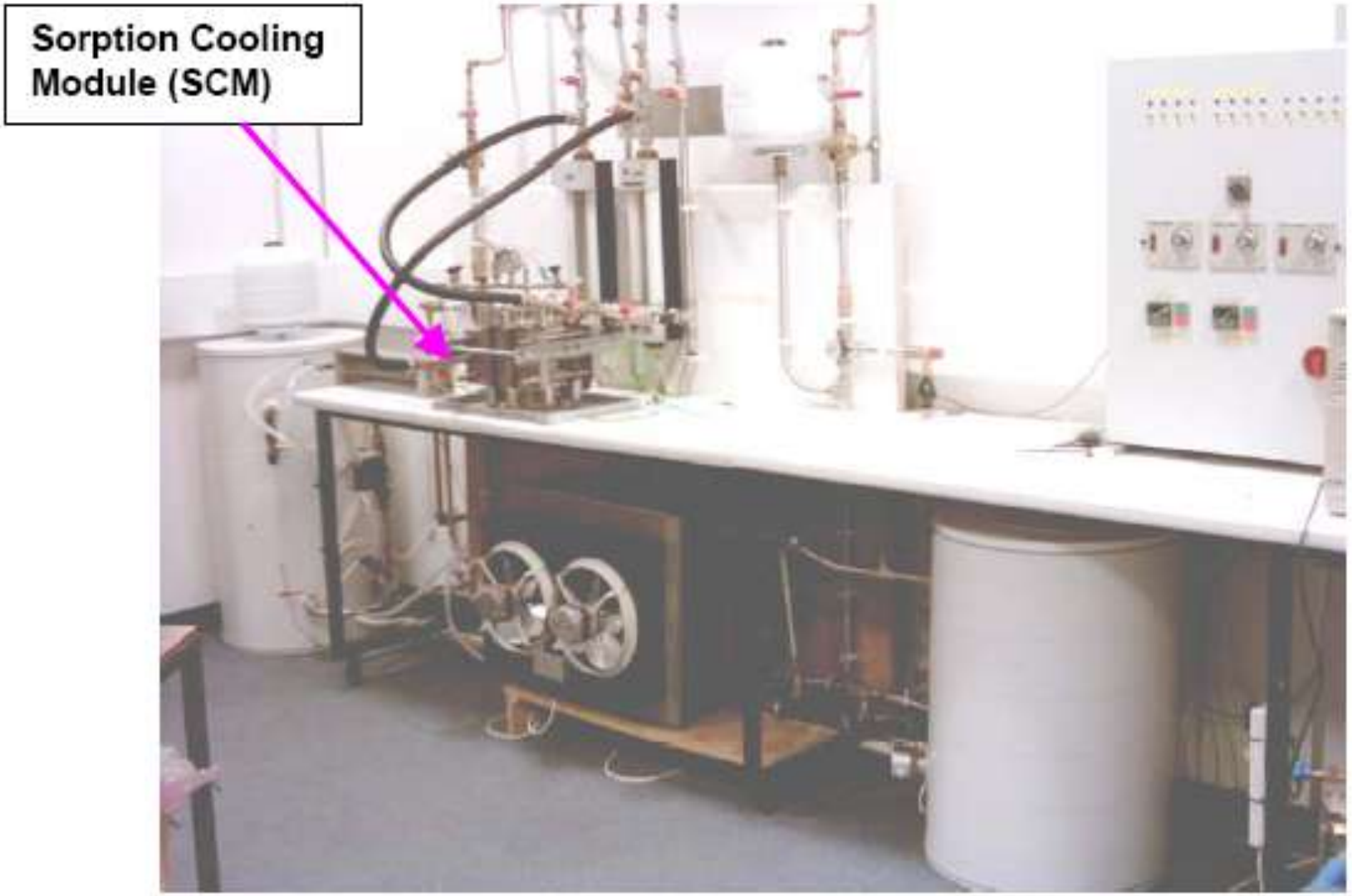
Prototype Manufacture



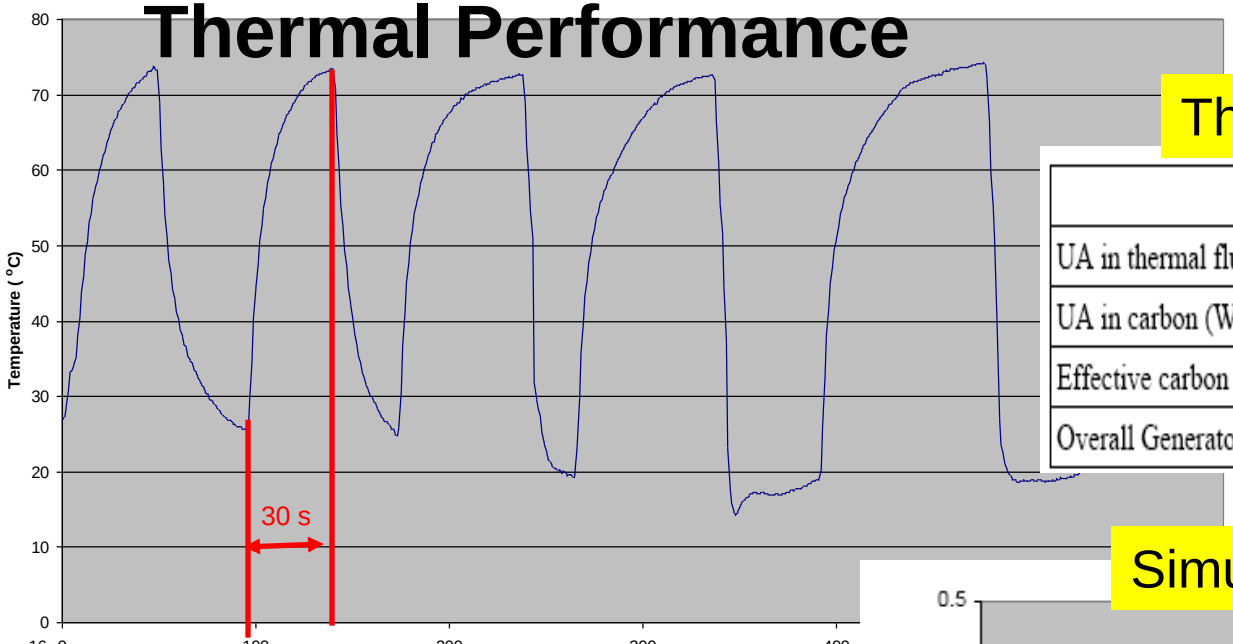
Type of carbon	SRD1532/3 (compacted)
Thermal enhancement additives	None
Sorbent density	435 kg/m^3
Mass of carbon	0.915 kg
Maximum ammonia concentration	0.57 kg ammonia/kg carbon
Total weight of reactor (without flanges)	9.5 kg
Type of gasket	PTFE Foam Sealant (RS-512-244)
Filter	Stainless Steel Mesh (Mesh grade 180)

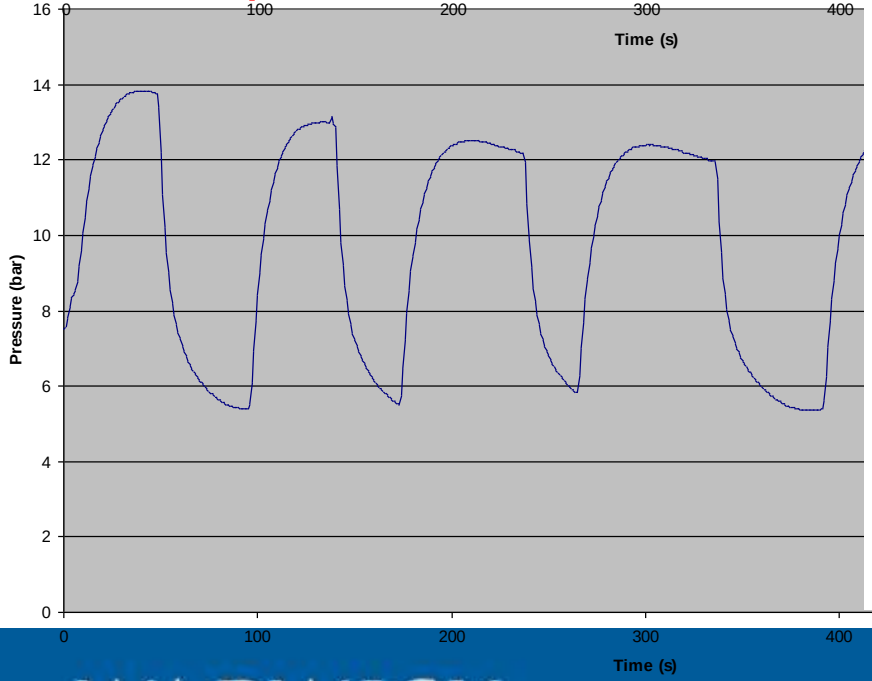
Thermal performance




Sorption Cooling
Module (SCM)

Thermal Performance

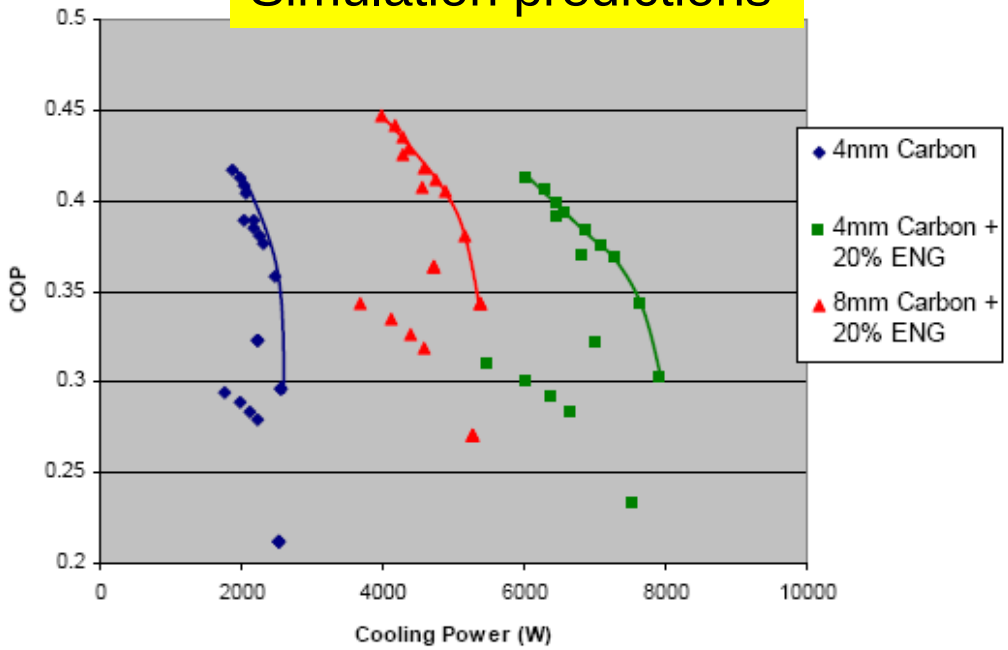




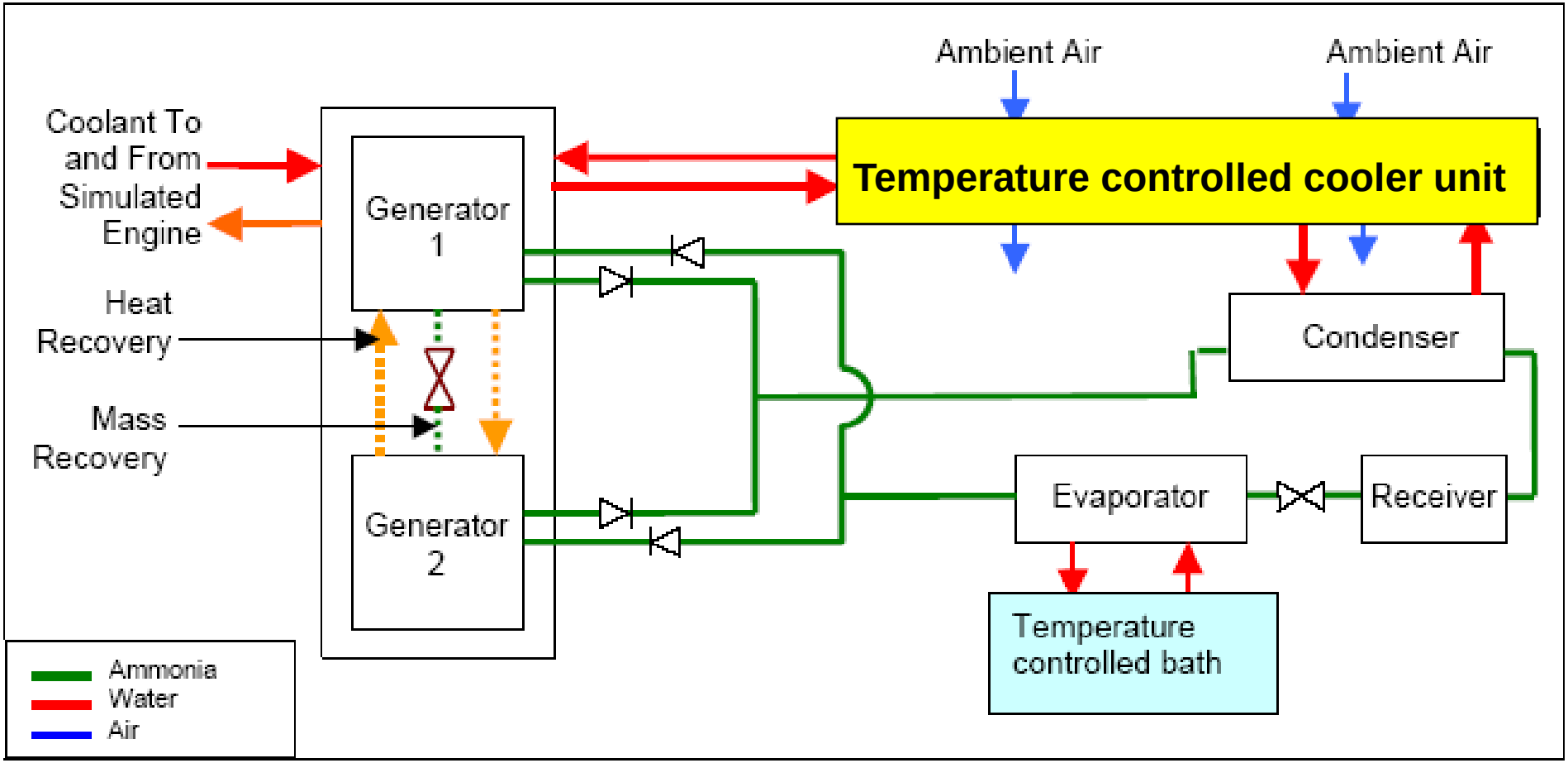
Thermal characteristics

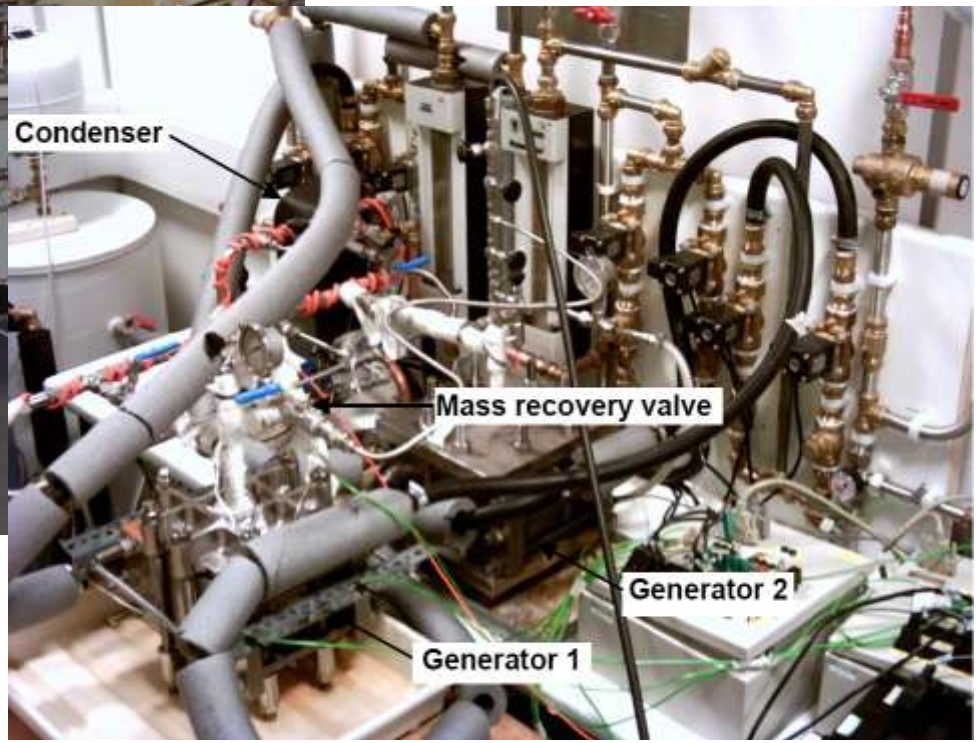
Parameter	
UA in thermal fluid channels ($W K^{-1}$)	4150
UA in carbon ($W K^{-1}$)	420
Effective carbon thermal conductivity ($W m^{-1}K^{-1}$)	0.42
Overall Generator UA value ($W K^{-1}$)	380

Simulation predictions

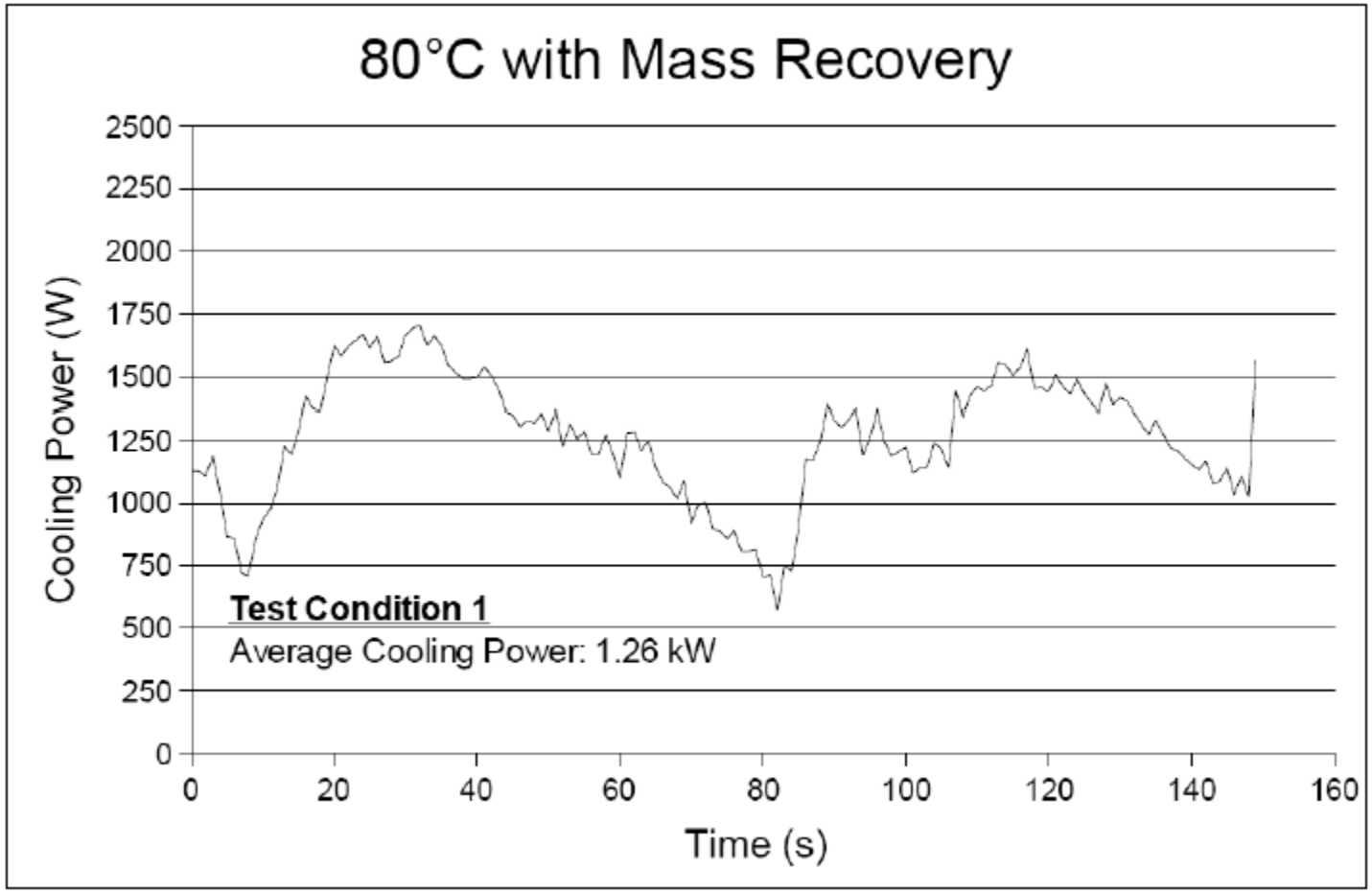


Lab scale Car HD A/C System



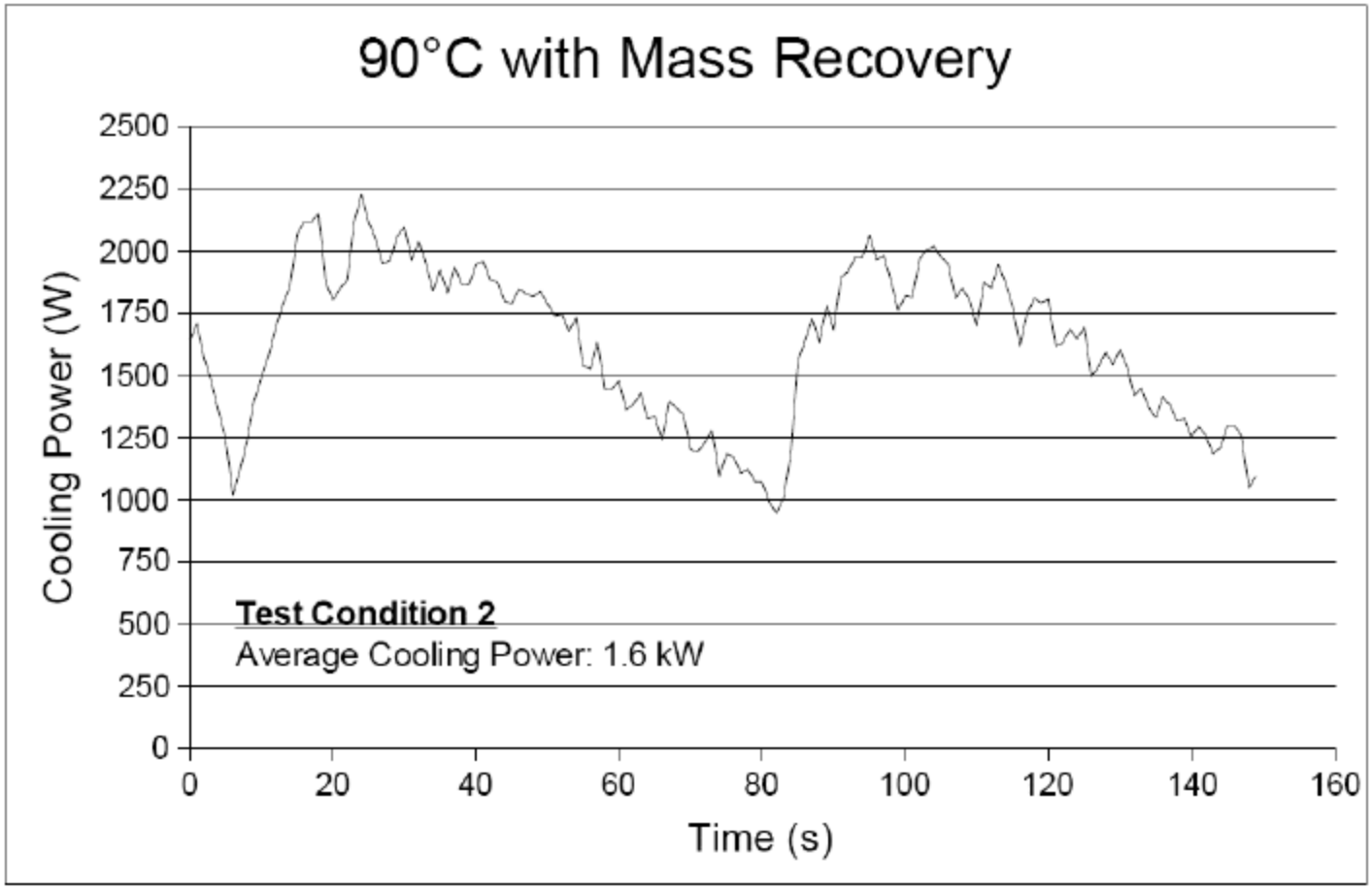

Condenser
Mass recovery valve
Generator 2
Generator 1

Lab scale Car HD A/C System



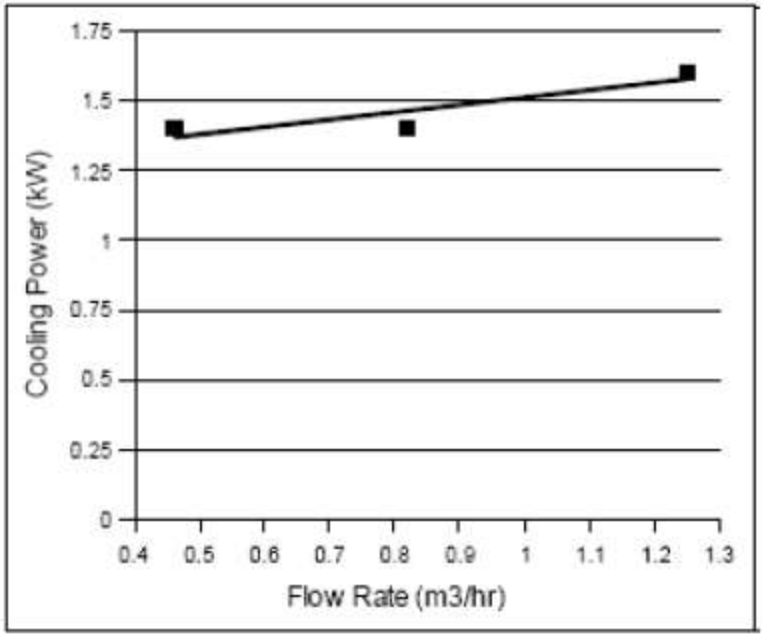
COP ~ 0.23

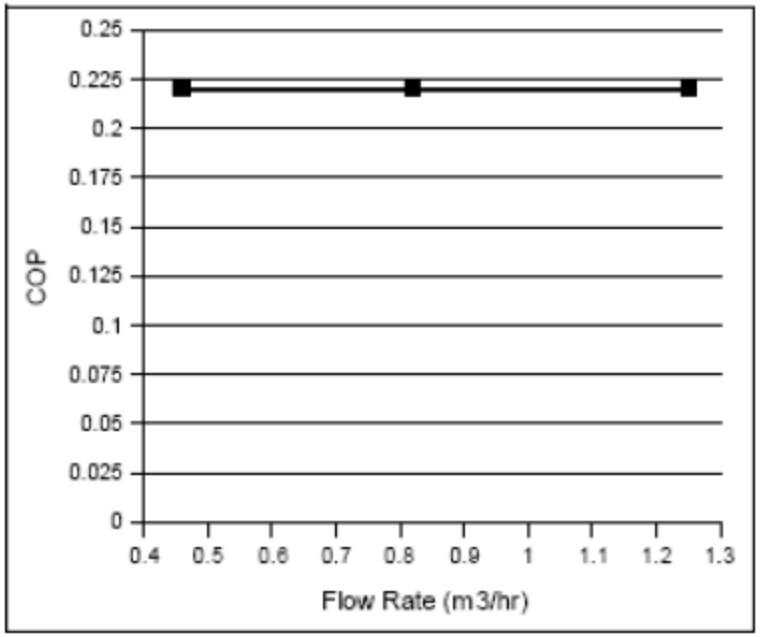
Lab scale Car HD A/C System



COP ~ 0.23

Lab scale Car HD A/C System





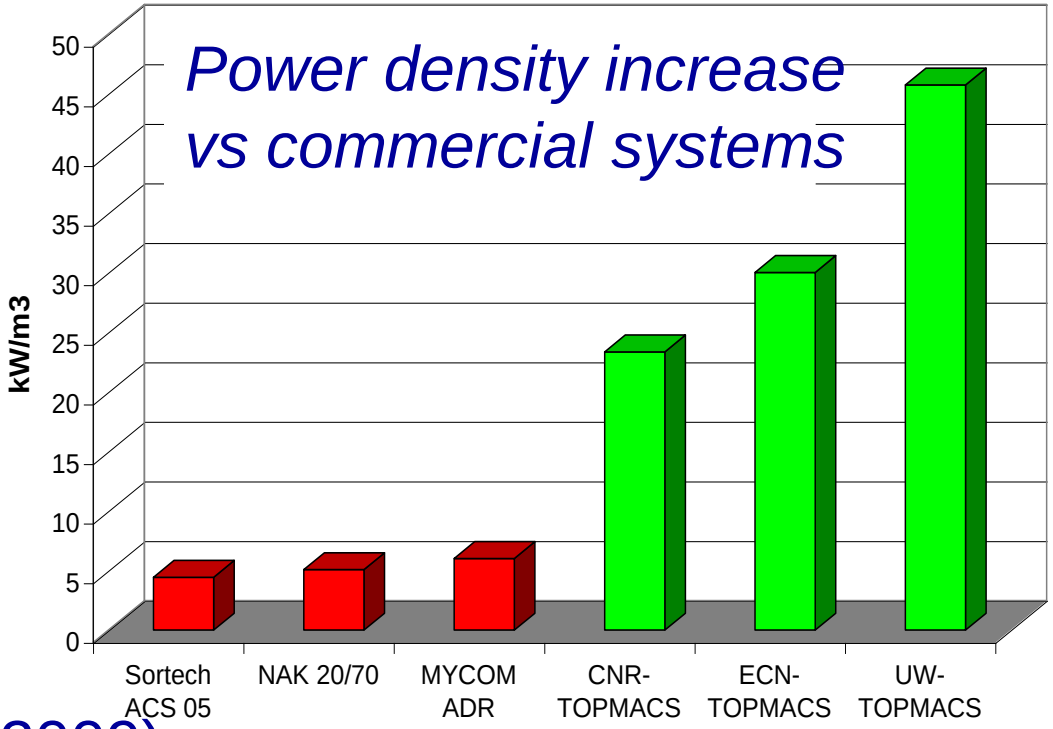
Summary : TOPMACS Lab Proto

Developing team	Univ. Warwick UW	CNR-ITAE	ECN
Working pair	CARBON AMMONIA	ZEOLITE WATER	SILICAGEL WATER
Thermal compressor volume / dm3	14	68	30
Sorbent weight /kg	2	6	5.7
Thermal compressor weight / kg	22	47	24
Characteristics	*Compact* *But heavy high-pressure containers*	*Reliable, fully automatic* *Stable performance* *Heavy vacuum containers*	*Reliable* *flexibility* *Non-condensables*

Summary: TOPMACS Lab Proto

Main Results

- Four bench prototypes realised and tested
- Fully validated virtual design tool



Next Steps (by first quarter 2009)

_ Truck prototype (CNR-ITEA)

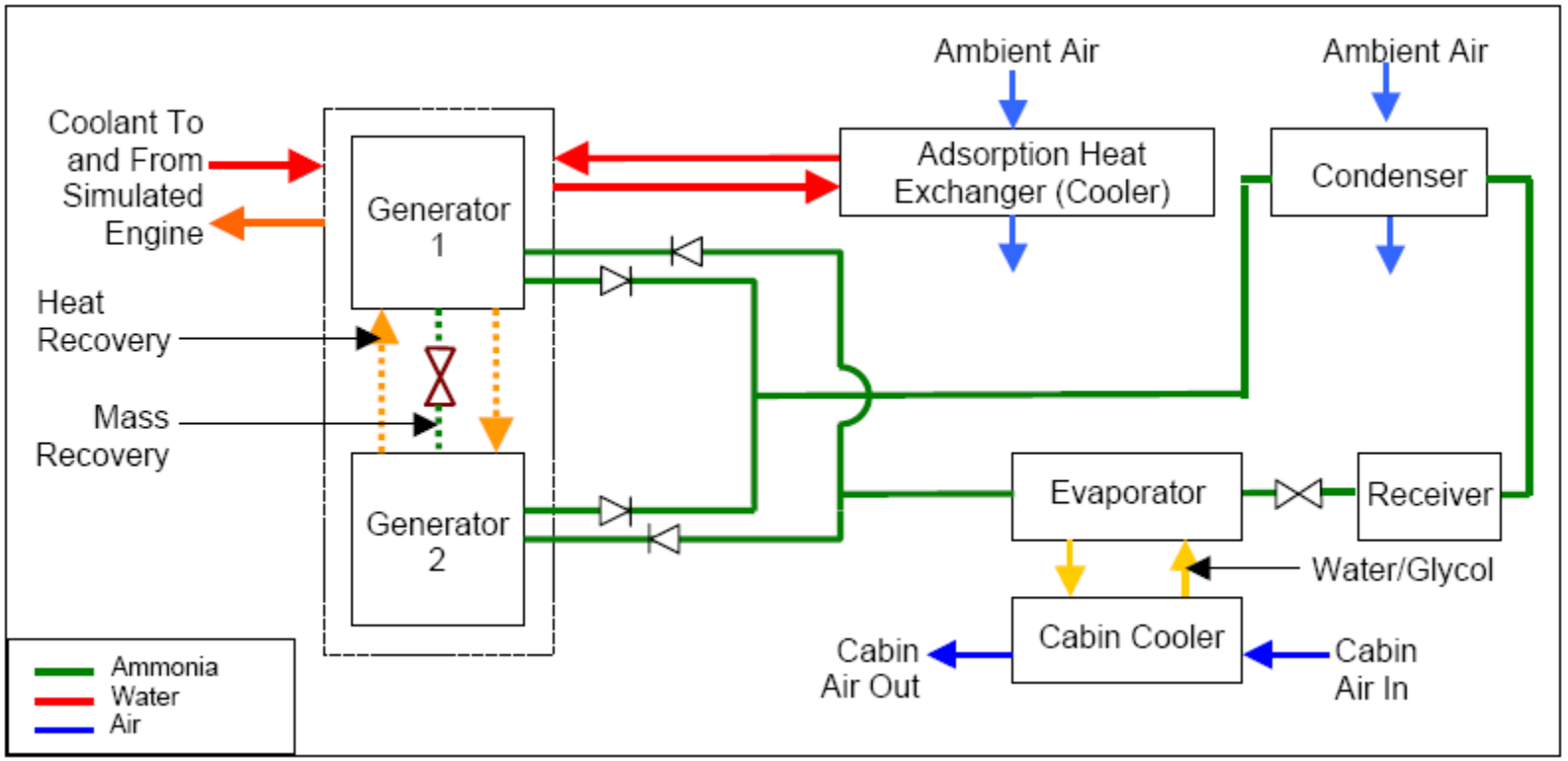
_ Car prototype (ECN)

_ **New package (UW)**

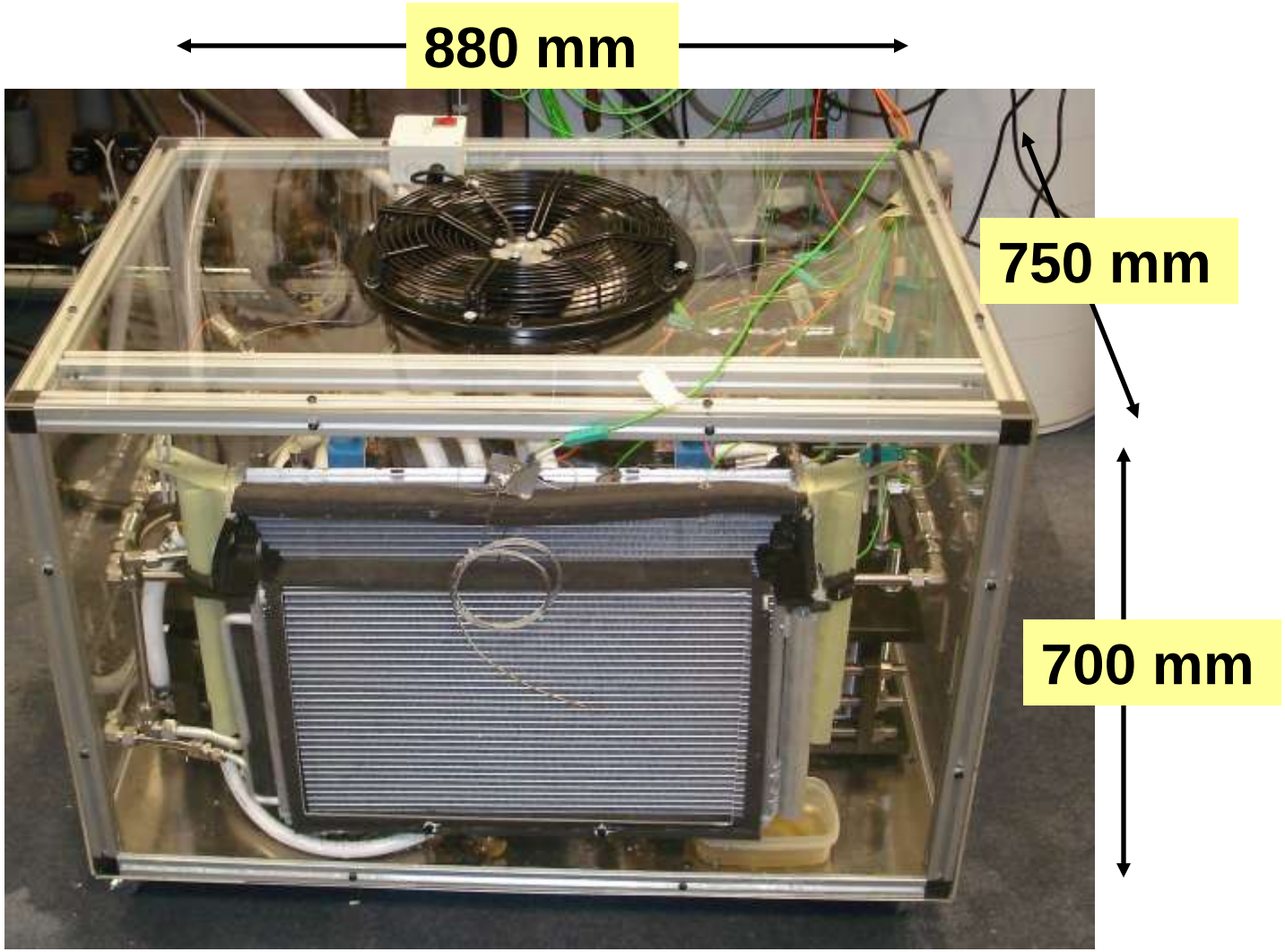
UW New Package:

- Good specific cooling power
- Improvement of COP
- Other developments:
  - check valves
  - water multiple ports valve
  - refrigerant flow control system
  - control strategy

UW New Package:



UW New Package:



Conclusions

Preliminary results:
1.6 kW – COP~0.23

Control development:
COP improvement

Concept proof of MACS